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L6: Entry 10 of 34

File: USPT

Feb 5, 2002

US-PAT-NO: 6343933

DOCUMENT-IDENTIFIER: US 6343933 B1

TITLE: Light-activated tooth whitening composition and method of using same

DATE-ISSUED: February 5, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|-------------------------|------------|-------|----------|---------|
| Montgomery; Robert Eric | Monterey | MA | | |
| Nathoo; Salim A. | Piscataway | NJ | | |

ASSIGNEE-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY | TYPE CODE |
|------------------|--------------|-------|----------|---------|-----------|
| BriteSmile, Inc. | Walnut Creek | CA | | | 02 |

APPL-NO: 09/ 651171 [PALM]

DATE FILED: August 30, 2000

PARENT-CASE:

The present application claims priority from provisional Application Ser. Nos. 60/074,708, filed Feb. 13, 1998 and 60/075,222, filed Feb. 19, 1998, and is a continuation of U.S. application Ser. No. 09/234,038, now U.S. Pat. No. 6,162,055 filed Jan. 19, 1999, all of the contents of which are hereby incorporated by reference into the present disclosure.

INT-CL: [07] A61 K 7/16

US-CL-ISSUED: 433/216; 433/215

US-CL-CURRENT: 433/216; 433/215

FIELD-OF-SEARCH: 433/29, 433/215, 433/216

PRIOR-ART-DISCLOSED:

*glycyls
disclosed,
not claim*

U.S. PATENT DOCUMENTS

Search Selected

Search ALL

| | PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|--------------------------|----------------|----------------|---------------|-------|
| <input type="checkbox"/> | <u>3499844</u> | March 1970 | Kibbel et al. | |
| <input type="checkbox"/> | <u>4130501</u> | December 1978 | Lutz et al. | |
| <input type="checkbox"/> | <u>4256730</u> | March 1981 | Benedict | |
| <input type="checkbox"/> | <u>4540504</u> | September 1985 | Eoga | |
| <input type="checkbox"/> | <u>4661070</u> | April 1987 | Friedman | |
| <input type="checkbox"/> | <u>4837008</u> | June 1989 | Rudy et al. | |
| <input type="checkbox"/> | <u>4970058</u> | November 1990 | Hills et al. | |

| | | | |
|--------------------------|----------------|---------------|------------------|
| <input type="checkbox"/> | <u>4971782</u> | November 1990 | Rudy |
| <input type="checkbox"/> | <u>4976955</u> | December 1990 | Libin |
| <input type="checkbox"/> | <u>4983380</u> | January 1991 | Yarborough |
| <input type="checkbox"/> | <u>4983381</u> | January 1991 | Torres Zaragoza |
| <input type="checkbox"/> | <u>5009885</u> | April 1991 | Yarborough |
| <input type="checkbox"/> | <u>5032178</u> | July 1991 | Cornell |
| <input type="checkbox"/> | <u>RE33786</u> | January 1992 | Pohl et al. |
| <input type="checkbox"/> | <u>5098303</u> | March 1992 | Fischer |
| <input type="checkbox"/> | <u>5171564</u> | December 1992 | Nathoo et al. |
| <input type="checkbox"/> | <u>5180573</u> | January 1993 | Hiramatsu et al. |
| <input type="checkbox"/> | <u>RE34196</u> | March 1993 | Munro |
| <input type="checkbox"/> | <u>5234342</u> | August 1993 | Fischer |
| <input type="checkbox"/> | <u>5240415</u> | August 1993 | Haynie |
| <input type="checkbox"/> | <u>5256402</u> | October 1993 | Prencipe |
| <input type="checkbox"/> | <u>5279816</u> | January 1994 | Church et al. |
| <input type="checkbox"/> | <u>5302375</u> | April 1994 | Viscio |
| <input type="checkbox"/> | <u>5376006</u> | December 1994 | Fischer |
| <input type="checkbox"/> | <u>5401495</u> | March 1995 | Murayama |
| <input type="checkbox"/> | <u>5409631</u> | April 1995 | Fischer |
| <input type="checkbox"/> | <u>5425953</u> | June 1995 | Sintov |
| <input type="checkbox"/> | <u>5531915</u> | July 1996 | Perkins |
| <input type="checkbox"/> | <u>5599525</u> | February 1997 | Hsu et al. |
| <input type="checkbox"/> | <u>5645428</u> | July 1997 | Yarborough |
| <input type="checkbox"/> | <u>5648064</u> | July 1997 | Gaffar et al. |
| <input type="checkbox"/> | <u>5676933</u> | October 1997 | Hauschild |
| <input type="checkbox"/> | <u>5690913</u> | November 1997 | Hsu et al. |
| <input type="checkbox"/> | <u>5713738</u> | February 1998 | Yarborough |
| <input type="checkbox"/> | <u>5718886</u> | February 1998 | Pellico |
| <input type="checkbox"/> | <u>5725843</u> | March 1998 | Fischer |
| <input type="checkbox"/> | <u>5746598</u> | May 1998 | Fischer |
| <input type="checkbox"/> | <u>5766011</u> | June 1998 | Sibner |
| <input type="checkbox"/> | <u>5770105</u> | June 1998 | Fischer |
| <input type="checkbox"/> | <u>5770182</u> | June 1998 | Fischer |
| <input type="checkbox"/> | <u>5785527</u> | July 1998 | Jensen |
| <input type="checkbox"/> | <u>5816802</u> | October 1998 | Montgomery |
| <input type="checkbox"/> | <u>5858332</u> | January 1999 | Jensen |
| <input type="checkbox"/> | <u>5922307</u> | July 1999 | Montgomery |

FOREIGN PATENT DOCUMENTS

| FOREIGN-PAT-NO | PUBN-DATE | COUNTRY | US-CL |
|----------------|---------------|---------|-------|
| 9114650 | October 1991 | WO | |
| 9804235 | February 1997 | WO | |
| 9711676 | April 1997 | WO | |
| WO 98/58595 | December 1998 | WO | |

OTHER PUBLICATIONS

Goldstein et al., eds., Complete Dental Bleaching, Ch. 4, Quintessence Publishing Co., Inc., Chicago (1995).

Montgomery et al., "Photoinduced Stain Removal in Bovine Enamel," Journal of Dental Research, 78: Abstract # 1158 (1999).

Ultradent Promotional Catalog, "Opalescence.RTM. Xtra.TM. Whitening Gel & OpalDam.TM. Reflective, Resin Barrier," Ultradent Products, Inc., pp. 1-4, Utah (1998).

Union Broach Operator's Manual, "Operating Instructions Illuminator," Union Broach, A Health-Chem Company, pp. 1-15.

Clinical Research Associates Newsletter, vol. 16, Issue 3, (Mar. 1992).

The Dental Advisor Plus, vol. No. 1, (Jan./Feb.1996).

C. G. Toh, "Clinical Evaluation of a dual-activated bleaching system"; Asian J. Aesthet. Dent, 1: 65-70, (1993).

QuasarBrite.TM., Contrast A.M..RTM., Laser Whitening Gel, Instructions for Use Manual, Interdent, Inc. (Los Angeles, CA).

QuasarBrite.TM., Contrast P.M..RTM., Laser Whitening Gel.

Shofu.RTM., HiLite.RTM. Dual Activated Bleaching System, Instruction Manual, Shofu Dental Corporation (Menlo Park, CA).

Van der Zee et al., "Hydroxyl Radical Generation By A Light-Dependent Fenton Reaction," Free Radical Biology & Medicine, vol. 14, pp. 105-113 (1993).

"Hydrogen Peroxide" in Kirk-Othmer Encyclopedia of Chemical Technology, 4.sup.th Edition, vol. 13, pp. 961-965, 983 (1995).

Provisional Patent application No. 60/004,258, to Robert E. Montgomery, filed Sep. 25, 1995.

Kitano, H. et al. "Modifications of a-Chymotrypsin Using a Water-Soluble Photo-Fenton Effect," Photochemistry and Photobiology 62: 809-812 (1995).

Zepp, G. et al., "Hydroxyl Radical Formation in Aqueous Reactions (p. 3-8) of Iron(II) with Hydrogen Peroxide: The Photo-Fenton Reaction," Environ. Sci. Technol. 26: 313-319 (1992).

Maletsky, P. et al., "Immobilisation of Iron Ions on Nafion.RTM. and Its Applicability to the Photo-Fenton Method," Chemosphere 38: 2315-2325 (1999).

Safarzadeh-Amiri, A. et al., "The Use of Iron In Advanced Oxidation Processes," J. Adv. Oxid. Technol. 1: 18-26 (1996).

Pignatello, J. et al., "Evidence for an Additional Oxidant in the Photoassisted Fenton Reaction" Environ. Sci. Technol. 33: 1832-1839 (1999).

Fallman, H. et al., "Applicability of the Photo-Fenton Method for Treating Water Containing Pesticides," Catalysis Today 54: 309-319 (1999).

Wu, K. et al., "Photo-Fenton Degradation of a Dye Under Visible Light Irradiation," Journal of Molecular Catalysis A: Chemical 144: 77-84 (1999).

ART-UNIT: 3732

PRIMARY-EXAMINER: Lewis; Ralph A.

ATTY-AGENT-FIRM: Kalow & Springut, LLP

ABSTRACT:

The present invention provides a tooth whitening composition having a transparent first component that is a carrier compound and a transparent second component that is an oxidizing compound which when applied to a stained tooth and exposed to actinic light is activated to facilitate tooth whitening. The invention also provides a method for light-activated tooth whitening which comprises applying a tooth-whitening composition to one or more teeth and exposing said composition to actinic light to activate said oxidizing compound.

43 Claims, 8 Drawing figures

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| Montgomery; Robert Eric | Monterey | MA | | |
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US-CL-CURRENT: 433/216; 433/215

CLAIMS:

What is claimed:

1. A method for light-activated tooth whitening comprising the steps of:

applying a tooth-whitening composition to one or more teeth, wherein the tooth whitening composition comprises a transparent carrier compound, a transparent oxidizing compound, a photosensitizer precursor which when in contact with the surface of a stained tooth becomes a photosensitizing agent, wherein the photosensitizing agent when exposed to actinic light activates the oxidizing compound to facilitate tooth whitening at the surface of the teeth, and

exposing the tooth-whitening composition to actinic light to activate the oxidizing compound.

2. A method according to claim 1, wherein the photosensitizer precursor is selected from the group consisting of ethylenediamine tetraacetic acid (EDTA), diethylenetriamine pentaacetic acid (DETPA), nitrilotriacetic acid (NTA), 1-hydroxyethylidene-1,1-diphosphonic acid, ethylenediamine tetra(methylenephosphonic acid) and diethylenetriamine penta(methylenephosphonic acid).

3. A method according to claim 2, wherein the photosensitizer precursor is 1-hydroxyethylidene-1,1-diphosphonic acid.

4. A method according to claim 1, wherein the actinic light has a wavelength in the range from about 380 nanometers to about 700 nanometers.

5. A method according to claim 1, wherein the actinic light has a wavelength in the range from about 380 nanometers to about 500 nanometers.

6. A method according to claim 1, wherein the transparent oxidizing compound is selected from the group consisting of peroxides, peroxyacids and combinations thereof.

7. A method according to claim 6, wherein the transparent oxidizing compound is a peroxide.

8. A method according to claim 7, wherein the peroxide is hydrogen peroxide.

9. A method according to claim 6, wherein the transparent oxidizing compound is a peroxyacid.

10. A method according to claim 9, wherein the peroxyacid is peroxyacetic acid.

11. A method of light-activated tooth whitening comprising the steps of:

applying a tooth-whitening composition to one or more teeth, wherein the tooth whitening composition comprises a transparent oxidizing compound, a transparent carrier, and a photosensitizer precursor which when chelated to endogenous metal ions present at the tooth surface becomes a photosensitizing agent, wherein the photosensitizing agent when exposed to actinic light activates the oxidizing compound to facilitate tooth whitening at the surface of the teeth, and

exposing the tooth-whitening composition to actinic light to activate the oxidizing compound.

12. A method according to claim 11, wherein the photosensitizer precursor is a metal ion chelator.

13. A method according to claim 11, wherein the photosensitizer precursor is selected from the group consisting of ethylenediamine tetraacetic acid (EDTA), diethylenetriamine pentaacetic acid (DETPA), nitrilotriacetic acid (NTA), 1-hydroxyethylidene-1,1-diphosphonic acid, ethylenediamine tetra(methylenephosphonic acid) and diethylenetriamine penta(methylenephosphonic acid).

14. A method according to claim 13, wherein the photosensitizer precursor is 1-hydroxyethylidene-1,1-diphosphonic acid.

15. A method according to claim 11, wherein the transparent oxidizing compound is selected from the group consisting of peroxides, peroxyacids and combinations thereof.

16. A method according to claim 15, wherein the transparent oxidizing compound is a peroxide.

17. A method according to claim 16, wherein the peroxide is hydrogen peroxide.

18. A method according to claim 11, wherein the transparent oxidizing compound is a peroxyacid.

19. A method according to claim 18, wherein the peroxyacid is peroxyacetic acid.

20. A method according to claim 11, wherein the endogenous metal ions are present in the saliva and the interstitial fluid of enamel and dentin.

21. A method according to claim 11, wherein the endogenous metal ions are transition metal ions.

22. A method according to claim 11, wherein the endogenous metal ions are selected from the group consisting of iron, manganese and copper.

23. A method according to claim 22, wherein the endogenous metal ions are iron.

24. A method according to claim 11, wherein the actinic light has a wavelength in the range from about 380 nanometers to about 700 nanometers.

25. A method according to claim 11, wherein the actinic light has a wavelength in the range from about 380 nanometers to about 500 nanometers.

26. A method for light-activated tooth whitening comprising the steps of:

applying a tooth-whitening composition to one or more teeth, wherein the tooth

whitening composition comprises a transparent oxidizing compound, a transparent carrier and a photosensitizer precursor which chelates endogenous metal ions present at the tooth surface and becomes a photosensitizing agent upon chelating the endogenous metal ions, and wherein the photosensitizing agent, when exposed to actinic light, activates the oxidizing compound to facilitate tooth whitening at the surface of the teeth, and

exposing the tooth-whitening composition to actinic light delivered from a position outside of a patient's mouth to activate the oxidizing compound.

27. A method according to claim 26, wherein the photosensitizer precursor is selected from the group consisting of ethylenediamine tetraacetic acid (EDTA), diethylenetriamine pentaacetic acid (DETPA), nitrilotriacetic acid (NTA), 1-hydroxyethylidene-1,1-diphosphonic acid, ethylenediamine tetra(methylenephosphonic acid) and diethylenetriamine penta(methylenephosphonic acid).

28. A method according to claim 27, wherein the photosensitizer precursor is 1-hydroxyethylidene-1,1-diphosphonic acid.

29. A method according to claim 26, wherein the transparent oxidizing compound is selected from the group consisting of peroxides, peroxyacids and combinations thereof.

30. A method according to claim 29, wherein the transparent oxidizing compound is a peroxide.

31. A method according to claim 30, wherein the peroxide is hydrogen peroxide.

32. A method according to claim 29, wherein the transparent oxidizing compound is a peroxyacid.

33. A method according to claim 32, wherein the peroxyacid is peroxyacetic acid.

34. A method according to claim 26, wherein the endogenous metal ions are present in the saliva and the interstitial fluid of enamel and dentin.

35. A method according to claim 26, wherein the endogenous metal ions are transition metal ions.

36. A method according to claim 26, wherein the endogenous metal ions are selected from the group consisting of iron, manganese, copper and combinations thereof.

37. A method according to claim 36, wherein the endogenous metal ions are iron.

38. A method according to claim 26, wherein the actinic light has a wavelength in the range from about 380 nanometers to about 700 nanometers.

39. A method according to claim 26, wherein the actinic light has a wavelength in the range from about 380 nanometers to about 500 nanometers.

40. A method of light-activated tooth whitening comprising the steps of:

contacting one or more tooth surfaces of a patient with an oxidizing composition comprising an oxidizing compound and a photosensitizer precursor, and

applying actinic radiation to the patient's one or more tooth surfaces.

41. A method according to claim 40, wherein the actinic radiation is transmitted through the oxidizing composition.

42. A method according to claim 40, wherein the actinic radiation is applied to the one or more tooth surfaces at from about 10 to about 200 milliWatt/cm^{sup.2}.

43. A method of light-activated tooth whitening comprising the steps of:

contacting one or more tooth surfaces of a patient with an oxidizing composition comprising an oxidizing compound and a photosensitizer precursor, wherein the oxidizing composition is sufficiently transparent to actinic radiation such that about 10 to about 200 milliWatt/cm.² of light can be applied to the one or more tooth surfaces, and

applying actinic radiation to the patient's one or more tooth surfaces.

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TITLE: Light-activated tooth whitening composition and method of using same

Brief Summary Text (4):

A tooth stain classification system, termed the N (Nathoo) Classification System, has been proposed (J. of the Amer. Dental Asso., Vol. 128, Special Supplement, April 1997). One form of direct dental stain is the N1 type stain which occurs when a chromogenic material binds to the tooth surface to cause discoloration similar in color to that of the unbound chromogen. Another type of direct dental stain is the N2 type stain, in which a chromogenic material binds to the tooth surface and subsequently undergoes a color change after binding to the tooth. Finally, an N3 stain is an indirect dental stain, caused by the binding of a colorless material (prechromogen) to the tooth, said prechromogen undergoing a chemical reaction that converts it into a chromogen that causes tooth stain. Tooth stains may be either extrinsic or intrinsic, depending upon their location within the tooth surface. For example, extrinsic staining of the acquired pellicle arises as a result of compounds such as tannins and other polyphenolic compounds which become trapped in and tightly bound to the proteinaceous layer on the surface of the teeth. This type of staining can usually be removed by mechanical methods of tooth cleaning that remove all or part of the acquired pellicle together with the associated stain. In contrast, intrinsic staining occurs when chromogens or prechromogens penetrate the enamel and dentin and become tightly bound to the tooth structure. Intrinsic staining may also arise from systemic sources of chromogens or prechromogens, for instance, when excess fluoride intake during enamel development leads to the mottled yellow or brown spots typical of fluorosis staining. Intrinsic staining is not amenable to mechanical methods of tooth cleaning and generally requires the use of chemicals, such as hydrogen peroxide, that can penetrate into the tooth structure, in order to affect a change in the light absorptivity of the chromogen. Intrinsic tooth staining is generally more intractable and difficult to remove than extrinsic tooth staining.

Brief Summary Text (6):

Among the chemical strategies available for removing or destroying tooth stains, the most effective compositions contain an oxidizing agent, such as hydrogen peroxide, in order to attack the chromogen molecules in such a way as to render them colorless, water-soluble, or both. In one of the most popular approaches to whitening a patient's teeth, a dental professional will construct a custom-made tooth-bleaching tray for the patient from an impression made of the patient's dentition and prescribe the use of an oxidizing gel to be dispensed into the tooth-bleaching tray and worn intermittently over a period of time ranging from about 2 weeks to about 6 months, depending upon the severity of tooth staining. These oxidizing compositions, usually packaged in small plastic syringes, are dispensed directly by the patient, into the custom-made tooth-bleaching tray, held in place in the mouth for contact times of greater than about 60 minutes, and sometimes as long as 8 to 12 hours. The slow rate of bleaching is in large part the consequence of the very nature of formulations that are developed to maintain stability of the oxidizing composition. The most commonly used oxidative compositions contain the hydrogen peroxide precursor carbamide peroxide which is mixed with an anhydrous or low-water content, hygroscopic viscous carrier containing glycerin and/or propylene glycol and/or polyethylene glycol. When contacted by water, carbamide peroxide dissociates into urea and hydrogen peroxide. Associated with the slow rate of bleaching in the hygroscopic carrier, the currently available tooth-bleaching compositions cause tooth sensitization in over 50% of patients.

Brief Summary Text (10):

Brief Summary Text (12) :

Brief Summary Text (14) :

A commercial product called Opalescence Xtra available for bleaching teeth in the controlled environment of a dental office has recently been introduced by Ultradent Products, Inc, South Jordan, Utah. This product is believed to be based on the disclosure of U.S. Pat. No. 5,785,527. The commercial product is supplied in a plastic syringe and is described in the accompanying literature as a light-activated tooth whitening gel, which contains approximately 35% hydrogen peroxide. A pH determination showed the product to have a neat pH at 25.degree. C. of about 4.0. The product is thickened to a loose, gel-like consistency with a polymer. Additionally, the product as sold, and as disclosed in U.S. Pat. No. 5,785,527, contains a bright orange pigment or dye (carotene), which presumably serves as the "photosensitizer". The manufacturer also claims that the photosensitizer is able to absorb light energy and convert it into heat energy, thereby increasing the activity of the peroxide as a tooth bleaching agent. The presence of a photoabsorber in the aforementioned composition renders it relatively opaque to wavelengths from about 400 to 700 nm. Exposure of this composition to light energy between 400 and 700 nm results in a gradual fading of the orange color, presumably due to a photobleaching effect in the presence of the hydrogen peroxide. Comparative clinical results show an improvement in tooth color of from about 3 to 4 VITA.RTM. shades, which is highly dependent upon the contact time of the composition on the tooth surface, rather than any particular light or heat activation regimen. In addition, the low pH of the commercial product may cause a reduction in the microhardness of tooth enamel, due to the dissolution of hydroxyapatite crystals (which can occur at a pH of around 5.5

or less).

Brief Summary Text (20):

It is yet another object of this invention to provide compositions and methods for whitening teeth whereby the extent of tooth whitening, in addition to the types of tooth stains removed, can be controlled by the duration, intensity and wavelength of actinic radiation exposure at the tooth surface.

Detailed Description Text (2):

This section details the preferred embodiments of the subject invention. These embodiments are set forth to illustrate the invention, but are not to be construed as limiting. Since the present disclosure is directed to those skilled in the art field and is not primer on the manufacture of tooth whitening compositions or their use or on devices for using such compositions, basic concepts and standard features known to those skilled in the art are not set forth in detail. Details for concepts such as choosing appropriate construction materials or ingredients, operating conditions or manufacturing techniques, etc. are known or readily determinable to those skilled in the art. Attention is directed to the appropriate texts and references known to those skilled in the art for details regarding these and other concepts which may be required in the practice of the invention; see, for example, Kirk-Othmer Encyclopedia of Chemical Technology, 4th Edition, Volumes 4 (1992), 13 (1995), 18 (1996), John Wiley & Sons, NY; Goldstein and Garber, Complete Dental Bleaching, Quintessence Publishing Co. 1995; and the aforementioned Journal of the American Dental Association, Vol. 128, Special Supplement, April 1997, the disclosures of which are hereby incorporated by reference into the present disclosure to aid in the practice of the invention. The development of the inventive compositions and methods described herein resulted from the unexpected discovery that extremely rapid tooth whitening occurs by allowing actinic radiation to penetrate through the oxidizing compound, which is placed directly onto the tooth surface to be whitened. This discovery is antithetical to all prior art compositions that include a light (or heat) absorbing additive dispersed directly in and homogeneously throughout the oxidizing compound. The inventive compositions, on the other hand, allow actinic radiation to reach the stained tooth surface at higher power densities than prior art compositions that are specifically designed to absorb light. Actinic radiation is thus more effectively utilized compared to prior art compositions and methods in which compositions are both opaque to most wavelengths of light and are activated directly by the actinic radiation. As the greatest oxidizing activity is required in the few millimeters of enamel and dentin at the tooth surface, the present inventive compositions and methods are more effective at removing tooth stains, in many cases with lower levels of active oxidizing agents, thereby resulting in safer compositions for use in the oral cavity.

Detailed Description Text (7):

It is preferred that the inventive photosensitizers are of a molecular size, charge, pH and hydrophobicity/hydrophilicity to allow for effective penetration into the deeper structures of enamel and dentin. The more readily a photosensitizer penetrates the tooth structure, the more likely that, upon exposure of the photosensitizer to actinic radiation at the appropriate wavelength and energy, said energy will be converted into oxidative activity at the site of, or in close proximity to, the chromogen itself. Photosensitizers having a molecular size, net charge, pH, and/or a hydrophobicity/hydrophilicity which prevent or limit penetration into deeper tooth structures are of utility in the practice of the present invention, but may be limited to the removal and/or destruction of chromogens located at the outer tooth surface (extrinsic stains).

Detailed Description Text (8):

Especially preferred photosensitizers belong to the general class of water-soluble metal-ligand complexes which absorb light in the range of from about 350 nm to about 700 nm. For the purposes of the present disclosure, the term "ligand" will mean an organic molecule capable of complexing or associating with a metal ion in aqueous solution, such that the reactivity, solubility, or any other physical property of said metal ion is changed. Such metal-ligand complexes are also known as metal-coordination complexes. Suitable metals ions include iron, manganese, copper, and other transition metal ions. Various valence states may be used or may be present simultaneously. The metal ions may be present in saliva, plaque, or the

Detailed Description Text (11):

Detailed Description Text (12):

Detailed Description Text (13):

The oxidizing compounds are liquid, gel, or solid compositions transparent to the wavelength(s) of light capable of activating the photosensitizing agent at the tooth surface; light energy otherwise will be attenuated by the film or layer of oxidizing compound between the actinic radiation source and the photosensitizer at the tooth enamel surface. As the tooth enamel surface is the location of the tooth discoloration, the most effective method of whitening teeth will occur when most or all of the light energy reaches the photosensitizer at the tooth enamel surface. An example of a suitable composition that is transparent to light energy between 380 and 500 nm is a 6% hydrogen peroxide gel with a pH of about 7.0 that has been thickened to approximately 100,000 cps with neutralized carboxypolymethylene.

The following oxidizing composition was prepared, which contained approximately 15% by weight hydrogen peroxide and 1 percent by weight of the photosensitizer precursor 1-hydroxyethylidene-1,1-diphosphonic acid (Dequest 2010, Monsanto Corp., St. Louis, Mo.). Highly purified water (18.2 megaohm, filtered through a 0.2 micron filter) was utilized in order to maintain good stability of the composition during storage. The composition was thickened with a carboxypolymethylene polymer (Carbopol 974P, B. F. Goodrich Co., Cleveland, Ohio) to the consistency of a light, non-runny gel. Glycerin was added in a small percentage as a humectant and stabilizer (as a free radical scavenger), and the Carbopol 947P was neutralized to a pH of 5.00 with ammonium hydroxide, resulting in the formation of a transparent and thixotropic gel.

The above composition was prepared in a plastic mixing chamber by combining, under agitation with a Teflon-coated mixing paddle until a clear solution was obtained, the distilled water, the 1-hydroxyethylidene-1,1-diphosphonic acid, and the glycerin. The Carbopol 974P was then sifted slowly into the vortex created by the mixing paddle and allowed to mix until a homogeneous slurry of the polymer was obtained. Finally, the ammonium hydroxide was added in a constant, dropwise fashion over a period of about 5 minutes until thickening and clarification of the slurry occurred. A pH probe was inserted periodically and the ammonium hydroxide addition proceeded until a pH of exactly 5.00 was obtained. The resulting gel contained 15% by weight hydrogen peroxide, and was highly transparent and thixotropic (non-slumping) in character.

Another transparent hydrogen peroxide gel was prepared that had a lower concentration of oxidizer (3% by weight of H₂O₂), but at a pH of 7.0 and a much higher viscosity (approximately 1,000,000 cps). The gel below was prepared in accordance with the procedure in Example I, except that a Kynar coated Ross Double Planetary vacuum mixer (Charles Ross & Sons, Hauppauge, N.Y.) was used to handle the elevated viscosity achieved during and after neutralization with the ammonium hydroxide. Sodium stannate was added as an additional stabilizer for the hydrogen peroxide.

The ability of the 3% hydrogen peroxide gel, transparent to visible light between the wavelengths of 380 and 700 nanometers, is demonstrated in Table 3 below.

| Ingredient | Percentage | Distilled water | 49.400 | 1-hydroxyethylidene-1,1-diphosphonic acid | 1.000 | Glycerin | 99.7 | 5.000 | Hydrogen peroxide | 35% | 42.900 | Carbopol 974P | 1.700 | Ammonium hydroxide 29% to pH 5.5 | TOTAL | 100.000 |
|------------|------------|-----------------|--------|---|-------|----------|------|-------|-------------------|-----|--------|---------------|-------|----------------------------------|-------|---------|
| | | | | | | | | | | | | | | | | |

| Ingredient | Percentage | Distilled water | 81.010 | Glycerin | 99.7% | 5.000 |
|---|------------|--------------------|--------|-------------------|-------|---------|
| 1-hydroxyethylidene-1,1-diphosphonic acid | 0.400 | Sodium stannate | 0.015 | Hydrogen peroxide | 35% | 8.570 |
| Carbopol 974P | 5.000 | Ammonium hydroxide | 29% | to pH 7.0 | TOTAL | 100.000 |

"Hydrogen Peroxide" in Kirk-Othmer Encyclopedia of Chemical Technology, 4.sup.th Edition, vol. 13, pp. 961-965, 983 (1995).

Zepp, G. et al., "Hydroxyl Radical Formation in Aqueous Reactions (p. 3-8) of Iron(II) with Hydrogen Peroxide: The Photo-Fenton Reaction," Environ. Sci. Technol. 26: 313-319 (1992).

8. A method according to claim 7, wherein the peroxide is hydrogen peroxide.

17. A method according to claim 16, wherein the peroxide is hydrogen peroxide.
31. A method according to claim 30, wherein the peroxide is hydrogen peroxide.

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TITLE: Light-activated tooth whitening composition and method of using same

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INVENTOR-INFORMATION:

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CLAIMS:

What is claimed:

1. A method for light-activated tooth whitening comprising the steps of:

applying a tooth-whitening composition to one or more teeth, wherein the tooth whitening composition comprises a transparent carrier compound, a transparent oxidizing compound, a photosensitizer precursor which when in contact with the surface of a stained tooth becomes a photosensitizing agent, wherein the photosensitizing agent when exposed to actinic light activates the oxidizing compound to facilitate tooth whitening at the surface of the teeth, and

exposing the tooth-whitening composition to actinic light to activate the oxidizing compound.

2. A method according to claim 1, wherein the photosensitizer precursor is selected from the group consisting of ethylenediamine tetraacetic acid (EDTA), diethylenetriamine pentaacetic acid (DETPA), nitrilotriacetic acid (NTA), 1-hydroxyethylidene-1,1-diphosphonic acid, ethylenediamine tetra(methylenephosphonic acid) and diethylenetriamine penta(methylenephosphonic acid).

3. A method according to claim 2, wherein the photosensitizer precursor is 1-hydroxyethylidene-1,1-diphosphonic acid.

4. A method according to claim 1, wherein the actinic light has a wavelength in the range from about 380 nanometers to about 700 nanometers.

5. A method according to claim 1, wherein the actinic light has a wavelength in the range from about 380 nanometers to about 500 nanometers.

6. A method according to claim 1, wherein the transparent oxidizing compound is selected from the group consisting of peroxides, peroxyacids and combinations thereof.

7. A method according to claim 6, wherein the transparent oxidizing compound is a peroxide.

8. A method according to claim 7, wherein the peroxide is hydrogen peroxide.

9. A method according to claim 6, wherein the transparent oxidizing compound is a peroxyacid.

10. A method according to claim 9, wherein the peroxyacid is peroxyacetic acid.

11. A method of light-activated tooth whitening comprising the steps of:

applying a tooth-whitening composition to one or more teeth, wherein the tooth whitening composition comprises a transparent oxidizing compound, a transparent carrier, and a photosensitizer precursor which when chelated to endogenous metal ions present at the tooth surface becomes a photosensitizing agent, wherein the photosensitizing agent when exposed to actinic light activates the oxidizing compound to facilitate tooth whitening at the surface of the teeth, and

exposing the tooth-whitening composition to actinic light to activate the oxidizing compound.

12. A method according to claim 11, wherein the photosensitizer precursor is a metal ion chelator.

13. A method according to claim 11, wherein the photosensitizer precursor is selected from the group consisting of ethylenediamine tetraacetic acid (EDTA), diethylenetriamine pentaacetic acid (DETPA), nitrilotriacetic acid (NTA), 1-hydroxyethylidene-1,1-diphosphonic acid, ethylenediamine tetra(methylenephosphonic acid) and diethylenetriamine penta(methylenephosphonic acid).

14. A method according to claim 13, wherein the photosensitizer precursor is 1-hydroxyethylidene-1,1-diphosphonic acid.

15. A method according to claim 11, wherein the transparent oxidizing compound is selected from the group consisting of peroxides, peroxyacids and combinations thereof.

16. A method according to claim 15, wherein the transparent oxidizing compound is a peroxide.

17. A method according to claim 16, wherein the peroxide is hydrogen peroxide.

18. A method according to claim 11, wherein the transparent oxidizing compound is a peroxyacid.

19. A method according to claim 18, wherein the peroxyacid is peroxyacetic acid.

20. A method according to claim 11, wherein the endogenous metal ions are present in the saliva and the interstitial fluid of enamel and dentin.

21. A method according to claim 11, wherein the endogenous metal ions are transition metal ions.

22. A method according to claim 11, wherein the endogenous metal ions are selected from the group consisting of iron, manganese and copper.

23. A method according to claim 22, wherein the endogenous metal ions are iron.

24. A method according to claim 11, wherein the actinic light has a wavelength in the range from about 380 nanometers to about 700 nanometers.

25. A method according to claim 11, wherein the actinic light has a wavelength in the range from about 380 nanometers to about 500 nanometers.

26. A method for light-activated tooth whitening comprising the steps of:

applying a tooth-whitening composition to one or more teeth, wherein the tooth

whitening composition comprises a transparent oxidizing compound, a transparent carrier and a photosensitizer precursor which chelates endogenous metal ions present at the tooth surface and becomes a photosensitizing agent upon chelating the endogenous metal ions, and wherein the photosensitizing agent, when exposed to actinic light, activates the oxidizing compound to facilitate tooth whitening at the surface of the teeth, and

exposing the tooth-whitening composition to actinic light delivered from a position outside of a patient's mouth to activate the oxidizing compound.

27. A method according to claim 26, wherein the photosensitizer precursor is selected from the group consisting of ethylenediamine tetraacetic acid (EDTA), diethylenetriamine pentaacetic acid (DETPA), nitrilotriacetic acid (NTA), 1-hydroxyethylidene-1,1-diphosphonic acid, ethylenediamine tetra(methylenephosphonic acid) and diethylenetriamine penta(methylenephosphonic acid).

28. A method according to claim 27, wherein the photosensitizer precursor is 1-hydroxyethylidene-1,1-diphosphonic acid.

29. A method according to claim 26, wherein the transparent oxidizing compound is selected from the group consisting of peroxides, peroxyacids and combinations thereof.

30. A method according to claim 29, wherein the transparent oxidizing compound is a peroxide.

31. A method according to claim 30, wherein the peroxide is hydrogen peroxide.

32. A method according to claim 29, wherein the transparent oxidizing compound is a peroxyacid.

33. A method according to claim 32, wherein the peroxyacid is peroxyacetic acid.

34. A method according to claim 26, wherein the endogenous metal ions are present in the saliva and the interstitial fluid of enamel and dentin.

35. A method according to claim 26, wherein the endogenous metal ions are transition metal ions.

36. A method according to claim 26, wherein the endogenous metal ions are selected from the group consisting of iron, manganese, copper and combinations thereof.

37. A method according to claim 36, wherein the endogenous metal ions are iron.

38. A method according to claim 26, wherein the actinic light has a wavelength in the range from about 380 nanometers to about 700 nanometers.

39. A method according to claim 26, wherein the actinic light has a wavelength in the range from about 380 nanometers to about 500 nanometers.

40. A method of light-activated tooth whitening comprising the steps of:

contacting one or more tooth surfaces of a patient with an oxidizing composition comprising an oxidizing compound and a photosensitizer precursor, and

applying actinic radiation to the patient's one or more tooth surfaces.

41. A method according to claim 40, wherein the actinic radiation is transmitted through the oxidizing composition.

42. A method according to claim 40, wherein the actinic radiation is applied to the one or more tooth surfaces at from about 10 to about 200 milliWatt/cm.sup.2.

43. A method of light-activated tooth whitening comprising the steps of:

contacting one or more tooth surfaces of a patient with an oxidizing composition comprising an oxidizing compound and a photosensitizer precursor, wherein the oxidizing composition is sufficiently transparent to actinic radiation such that about 10 to about 200 milliWatt/cm.² of light can be applied to the one or more tooth surfaces, and

applying actinic radiation to the patient's one or more tooth surfaces.